

Application of the DEMATEL Method to Identify Relations among Barriers between Green Products and Consumers

Jing Shao^{a,b,1}, Marco Taisch^a, Miguel Ortega Mier^b, Elisa d'Avolio^c

^aDept. of Management, Economics and Industrial Engineering, Politecnico di Milano, Milan, Italy

^bDept. of Industrial Engineering, Business Administration and Statistics, Universidad Politécnica de Madrid, Madrid, Spain

^cDept. of Industrial Engineering, University of Florence, Florence, Italy

Abstract

Sustainable Production and Consumption (SPaC) is an emerging topic since last decades. Changing unsustainable consumption patterns is crucial for achieving the goal of sustainable development. From literature, although consumers begin to have a concern about environmental and social performance of products they are purchasing, these concerns are not necessarily translated to consumer purchase habits. This phenomenon has been noticed in academia and numbers of studies have addressed possible barriers between green products and, but literature in deep investigating and analyzing significance of various barriers are limited. In this study, eight barriers exist between green products and consumers have been specified based on literature. Furthermore, a barriers analysis has been conducted by applying DEMATEL technique, and barrier which has greatest impact has been distinguished. The analysis result showed that “Format of information presentation” has the greatest prominence value and it means this barrier has the greatest impact. And it is found that this barrier is significantly influenced by barrier of “Inadequate information on the product when purchasing”. Additionally, barrier of “Acknowledgement on influence of collaborative purchasing behavior” has become one of the most important factors in the whole system. This study brings important insights of analyzing on barriers between green products and consumers through an original way. Based on analyzing results, further research directions are provided at the end.

Highlights:

- The study explores the significance of various barriers and how the barriers relate to each other.
- DEMATEL is applied to model and evaluate the interrelationships among eight barriers.
- The study provides basic understanding for improving SPaC of organizations.
- The result shows that it is important to assure providing adequate quantity of necessary information.
- The study found that education and communication on consumers becomes one of the most important factors in the whole system.

Keywords: Sustainable Production and Consumption, Green Products, Consumers, DEMATEL, barrier analysis

1. Introduction

The definition of Sustainable Production and Consumption (SPaC) is: “the use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of

¹ Corresponding author: Jing Shao

Email: jing.shao@polimi.it

Present address: Via R. Lambruschini, 4B, 20156 Milano, Italy, Ph.+39 02 2399 2721

natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardize the needs of future generations” (Oslo, 1994). SPaC attracts attention of researchers and practitioners since decades ago. The first time it became a policy concept was in Agenda 21 (UN, 1992). Then it was reaffirmed as the central role in achieving sustainable development in World Summit for Sustainable Development. The revised European Sustainable Development Strategy of 2005 set the goal of more sustainable consumption and production patterns firmly on the political agenda in Europe (EU, 2008). Especially from June 2012, research which focus on SPaC has emerged after the “Global Research Forum on Sustainable Production and Consumption” (Lorek et al., 2013).

Sustainable consumption (SC) is equally important to limit negative environmental and social externalities as well as to provide markets for sustainable products (OECD, 2008). It becomes complementary strategies with sustainable production (SP) for making economics more sustainable (Luskin and Del Matto, 2007). It is because sustainability (or the lack of it) depends on the individual actions of over 6 billion human beings (Dahl, 2012) and consumer buying behavior reflects their consumption patterns and lifestyles. Unsustainable consumption patterns and levels, in particular in industrialized countries, are a major cause if not the major cause of environmental degradation in the world today (UNDP, 1998; Worldwatch, 2004).

However, from literature, it is hard for individuals to appreciate the significance of the cumulative impact of serials small actions that may have a sustainable impact to the world. It is discussed that awareness of influence of collaborative buying behavior is insufficient in consumers’ minds (Shao et al., 2014b). But more importantly, because even for green consumers who are much more concerning about sustainability related issues, information transition is lack from sustainable production to sustainable consumption (Lebel and Lorek, 2008).

A number of theoretical and empirical studies have addressed possible barriers between green products and consumers (see section 2.2), but literature in deep investigating and analyzing significance of various barriers are limited. For effective improving SPaC, organizations need to have basic understanding on the relationship among these barriers, and then be able to determine how they should overcome the barriers. These barriers are crucial for developing a holistic policy of organizations.

With this situation, this paper explores the significance of various barriers and how the barriers relate to each other. To model and evaluate the interrelationships among the barriers, this paper applies a grey- based Decision-Making Trial and Evaluation Laboratory (DEMATEL) (Zhu et al., 2011). The overall purpose and contribution of this paper is to gain insights about the barriers between green products and consumers and to provide basic understanding for improving SPaC of organizations. In order to meet this objective, a description regarding sustainability management of fashion industry will be provided first. Secondly, company involved in this case study will be briefly introduced. Then, various potential barriers between green products and their consumers will be specified. After that, the application of DEMATEL methodology will be performed and an exploratory analysis of these barriers will be introduced. The result will be discussed and managerial insights, with possible direction of further research will be provided at the end.

2. Background

2.1 Introduction of fashion industry

Fashion is a complex phenomenon that shows interesting insights from different points of view: psychological, sociological, commercial and engineering. Fashion industry is strongly dependent from the consumers' needs so that effectiveness has always been the main factor that each company has taken into account. Time-to-market (TTM) and quality of products represent the main critical success factors (CSFs). Indeed, fashion industry involve several kinds of environmental impacts in their production process, such as dyeing, drying, finishing (de Brito et al., 2008). Recent studies showed, more and more multinational brands have positioned themselves in the "green" segment of the market with including environmental aspects into a new concept of quality of their green products (Caniato et al., 2012). Meanwhile, some SMEs also have leveraged on environmental sustainability in their business model and supply chain structure, in order to compete in new market niches and establish their brand (Caniato et al., 2012).

The footwear market is one of the biggest markets in fashion industry. EU has the largest market for footwear having about one third of the market value. At the same time, EU has been considered as one of the high quality footwear suppliers in terms of production. Currently, footwear market faces different emerging trends from both consumers and practitioners' perspectives. Consumers are more concerned about the economic value of the products they buy as a result of the recent economic crisis. Meanwhile there are customers, especially in Northern and Western European countries, caring more about eco-design and concerning about materials and circumstance for shoe production (Pourabdollahian, 2013). Environmental concerns have become a major concern for European shoe producers considering the fact that leather production is one of the most polluting industries. In this regard, the manufacturers need to invest in applying green technologies especially for leather tanning. Such a shift can also bring a competitive advantage to them and differentiating them from their Asian competitors by offering not only high quality but also eco-friendly shoes.

This case study conducted in company "X" which was founded in 1996 by shoe designer. Now it becomes a British high fashion house specializing mainly in footwear, but also handbags, accessories and fragrances. It has several shops in UK and two branches in Italy. The headquarter is in London where Design, Product Development and Merchandise Planning processes are coordinated. There, the main stylists take the most part of the decisions about the collections and the catwalk. In Italy the company manages the operative side of the Product Development process and also the Production process is carried out. The brand takes advantage from the exceptional Italian craftsmanship: the center of Italy stands out for the great number and the high handcrafted tradition of small and medium enterprises, where the company can find its best leather suppliers.

2.2 Specify barriers

From literature of consumer studies, although consumers began to have a concern about environmental and social performance of products they are purchasing, these concerns are not necessarily translated to consumer purchase habits. Studies showed that even consumers who are environmentally concerned do not buy green products in overwhelming preference (Tseng and Hung, 2013). The inconsistency between their environmental attitudes and corresponding behavioral intentions has been noticed in academia, as numbers of studies in organic food

industry indicated. The potential barrier factors which stand between green products and consumers in general are summarized in this section based on literature and practices.

2.2.1 External barriers

Five external barriers which related to relationships between products and consumers are specified as following. “Green customers” who are sensitive to energy saving and environment protection are ignorant of how to make better purchasing decisions, since lack of energy consumption and environmental impact information of products. It is also discussed in literature that the degree to which consumer use environmental information of a product is disputed (Leire and Thidell, 2005). This problem involves two dimensions as barriers 1 & 2:

Barrier1. Inadequate information about market of green product:

The awareness of existing of green products is lack in current marketing mainly attribute to their tiny shares of market (Bonini and Oppenheim, 2008; Rööös and Tjärnemo, 2011). This point of view leads by low availability of green products and they are said to be usually hard to find in normal market.

Barrier2. Inadequate information about the environmental/socially-conscious attributes of product when purchasing:

Green consumers need knowledge, skills and information for making the correct decisions, but information is often confusing. This may either demotivate or serve as an excuse (Moisander, 2007). Some studies showed that consumers are increasingly demanding more information regarding a product's supply chain and production history (Maruchek et al., 2011). But gap between consumer informational needs and current market offerings exist (Shao et al., 2014a; Meise et al., 2014). The obstacle is the lack of adequate information from which allows consumers to obtain reliable information about environmental/socially-conscious attributes of a product, and make informed purchasing decisions (Meise et al., 2014; Caniato et al., 2012).

Barrier3. Consumers are lack of trust

Literature has a wide discussion that consumer trust and motivation are the key determinants for consumers to accept related information of product. However, although Eco labeling has become policy tool in marketing, sustainable consumption patterns is still on a voluntary basis to a large extent. Numerous eco-labels offered extraordinary chances for customers to get the green related information, but it confused consumers mainly because most of them provide polarity, repeat and incomplete information (Lebel and Lorek, 2008; Leire and Thidell, 2005). Furthermore, consumers are distrustful and suspicious of environmental advertising and claims from industry (Rex and Baumann, 2007).

Barrier4. Format of information presentation

Currently, eco-labels are the main approach in marketing to provide sustainable information of products. However, such sustainability labels currently do not play a major role in consumers' food choices (Grunert et al., 2014). Marketing patterns of information which provided to the consumer have become one of the key issues in this subject. From manufacturing studies, numbers of indicators have been provided by international environmental organizations, industries practitioner or researchers, but most of them have long lists of environmental pollutants and abounding with technical terms (Shao et al., 2014b). They are designed only adaptable for

industrial application or academic research, but not for the time limited situations such as purchasing.

Barrier5. Non-competitive price

Studies have shown that perceived high price is the main barrier to purchase and use sustainable products (Röös and Tjärnemo, 2011). And some studies showed the willingness to pay extra for green products was less than anticipated (Rex and Baumann, 2007). It is because green products normally have even higher price that mainly attribute to the cost of production and transportation. It makes consumers harder to make a decision to accept green products many times although they are intent to be green.

2.2.2 Internal barriers

Different from external barriers, internal barriers mainly concerns about the mental and initial factors which influence purchasing behavior of consumers. Three internal barriers are specified from literature as following.

Barrier6. Acknowledgement on influence of collaborative purchasing behavior

In consumer behavior studies, consumers are often assumed to possess a considerable amount of knowledge about complex ecological or ethical issues and their consequences (Grunert et al., 2014; Moisander, 2007), and it might be a reason to explain the inconsistency between consumer attitude and behavior (Rokka and Uusitalo, 2008). From manufacturing perspective, their collaborative purchasing decisions is one of the incentives for manufacturers to adopt clean(er) technologies, However, acknowledgement on this possible consequence is not accessible for consumers. Corresponding education and communications on the awareness of influence from collaborative purchasing behavior are rarely to observe in reality.

Table 1. List of barriers

No.	Barrier	Literature
B1	Inadequate information about market of green product	(Bonini and Oppenheim, 2008; Röös and Tjärnemo, 2011)
B2	Inadequate information on the product when purchasing	(Moisander, 2007; Maruchek et al., 2011; Shao et al., 2014a; Meise et al., 2014; Caniato et al., 2012)
B3	Consumers are lack of trust	(Rex and Baumann, 2007; Lebel and Lorek, 2008; Leire and Thidell, 2005)
B4	Format of information presentation	(Grunert et al., 2014).
B5	Non-competitive price	(Rex and Baumann, 2007; Röös and Tjärnemo, 2011)
B6	Acknowledgement on influence of collaborative purchasing behavior	(Grunert et al., 2014; Moisander, 2007; Rokka and Uusitalo, 2008)
B7	Gaps exist between customers' expectations and their perceptions	(Tseng and Hung 2013)
B8	Consumers are lack of motivation	(Rokka and Uusitalo, 2008; Leire and Thidell 2005; Rex and Baumann 2007; Moisander, 2007)

Barrier7. Gaps exist between customers' expectations and their perceptions

Studies have verified that customers' expectations are higher than their perceptions in 11 items which related to environmental attributes of green information products, by comparing between the mean value of customers' expectations and their perceptions. So to speak, the products in the market do not meet the expectation of customers (Tseng and Hung 2013).

Barrier8. Consumers are lack of motivation

Presently, even green consumers who are much more concerning about sustainability related issues, do not have sufficient motivation to enable them making greener buying decisions (Rokka and Uusitalo, 2008; Leire and Thidell 2005; Rex and Baumann 2007). For green consumers it is often difficult to decide what is the correct thing to do (Moisander, 2007).

The list of the barriers is presented in the Table 1.

2.3 Questionnaire development and data collection

This study focused on identifying and interviewing industrial expert to validate the barriers identified from literature. The respondent we selected is a research fellow at the Industrial Engineering Department in Italy. Now she is a consultant working in High Fashion Industry. Her research interests were related to the fashion supply chain in the Luxury Industry. The expert is able to provide a more complete picture of green product and their consumers, both from academic and industrial perspective.

The questionnaire with three parts has been developed in order to provide complete information to respondent. The first part of questionnaire described the main focus and objective of this study. Then the definitions of barriers have been explained and listed. Lastly, core data is required for further DEMATEL analysis. It was composed of a matrix that required completion by respondent.

3. Methodology

3.1 Evaluating practices adoption

Previous studies have utilized different methods to analyze interrelationships between factors influencing practices. Studies on barriers between green products and their consumers have been conducted by several researchers (Röös and Tjärnemo, 2011; Vermeir and Verbeke, 2006). However, the internal relationships among those barriers are lack.

This study attempts applies Decision-Making Trial and Evaluation Laboratory (DEMATEL) to analyze the barriers between green products and consumers, and their interrelationships to each other. It could be applied to have insights on determinant factors among various barriers. DEMATEL was employed firstly in 1976 and it has managed to solve many global complex problems by considering experts' attitudes, and became a widespread technique in Japan (Falatoonitoosi et al., 2013). Then, this method has been applied in many areas such as knowledge management (Wu and Lee, 2007) and sustainable production (Dou and Sarkis, 2013), green supply chain management (Amiri et al., 2011; Jalalifar et al., 2013). The technique has proven valuable also for managerial decision-making support in environmental and greening issues (Zhu et al., 2008).

3.2 Grey-DEMATEL Method

The analysis was performed based on guidelines presented in (Zhu et al., 2011), where you may also find detailed description of every step. Here, the application of DEMATEL method on company "X" in fashion industry of Italy will be shown as following.

Step1. Define a grey pairwise influence comparison scale for the components. In this study, a 5-level scale was used with the following scale items: 0= no influence, 1= very low influence, 2=

low influence, 3= high influence, 4= very high influence. The grey linguistic scale for the respondents' evaluations is shown in Table 2.

Table 2. The grey linguistic scale for the respondents' evaluations

Linguistic terms	Grey numbers	
No influence	[0,0]	0
Very low influence	[0,0.25]	1
Low influence	[0.25,0.5]	2
High influence	[0.5, 0.75]	3
Very high influence	[0.75,1]	4

Step2, Development of the grey pairwise direct- relation matrix X. It is an 8×8 matrix whose assessment number was provided by evaluator. The grey pairwise direct-relation matrix X is shown in Appendix A.

Step3, Transform the grey pairwise direct-relation matrix X into a crisp matrix Z. The overall crisp direct- relationship matrix is shown in Appendix B.

Step4, Obtain the normalized direct-relation matrix N, based on the formula (1) and (2). The normalized direct-relation matrix N is shown in Appendix C.

Step5. Develop the total relation matrix T, based on the formula (3), where “T” represents an n×n identity matrix (Appendix D).

Step6. Calculate the overall importance and net effect, applying formula (4-7), where P_i is prominence and E_i is net effect. The degree of prominence and net effects is shown in Table 3.

Table 3. The degree of prominence and net effects

Barriers	Prominence (R+D)	Net Effect (R-D)
B1	8.4536	-0.3404
B2	7.6225	0.4111
B3	9.2918	-1.3913
B4	10.0076	0.1089
B5	6.1935	1.3673
B6	8.0208	0.5269
B7	6.8551	-0.5116
B8	9.6687	-0.1708

Step7. Develop DEMATEL prominence-causal graph (Fig.1).

Interrelationships between barriers are indicated with arrows. Only relationships that are over the threshold value θ (0.6589) were in bold in Appendix D and mapped in Fig.1. The threshold equals to the sum of mean (0.5165) and standard deviation (0.1424) of the values from matrix T (Appendix D). All the relationships are represented by solid line in Fig. 1. In this case, only relationship between B4 and B8 has two-way significant relationship. Other significant relationships were: B1-B3, B1-B8, B2-B4, B4-B1, B4-B3, B5-B8, B6-B3 and B8-B3.

4. Results and Discussions

The result of this study shows four barriers that can be identified as net-cause barriers. These four barriers are B4, B8, B3, B1, consequent by their ranking of prominence. Industrial expert views B4 as the most important one with the highest prominence score of 10.0076. Therefore B4 (Format of information presentation) has the greatest impact in the system and it has positive net effect to other barriers. B8 (Consumers are lack of motivation) influences B3, and B8 is influenced by B1, B4 and B5. It indicates that for achieving consumers' trusting, consumers need

more motivation which needs to be assured from three perspectives. Besides more competitive price of green product, it is necessary to provide consumers proper format of green information of products and extend their markets. The third prominent barrier B3 (Consumers are lack of trust) is also the one who has greatest negative net-effect scores. It means that other factors may need to be initially addressed in order to remove these barriers. From arrows in Fig. 1, it can be seen that these factors are B1, B4, B6 and B8. Moreover, B4 has the greatest T value on B3. This result means, improving format of information presentation is crucial for increasing consumers' trusting on green products.

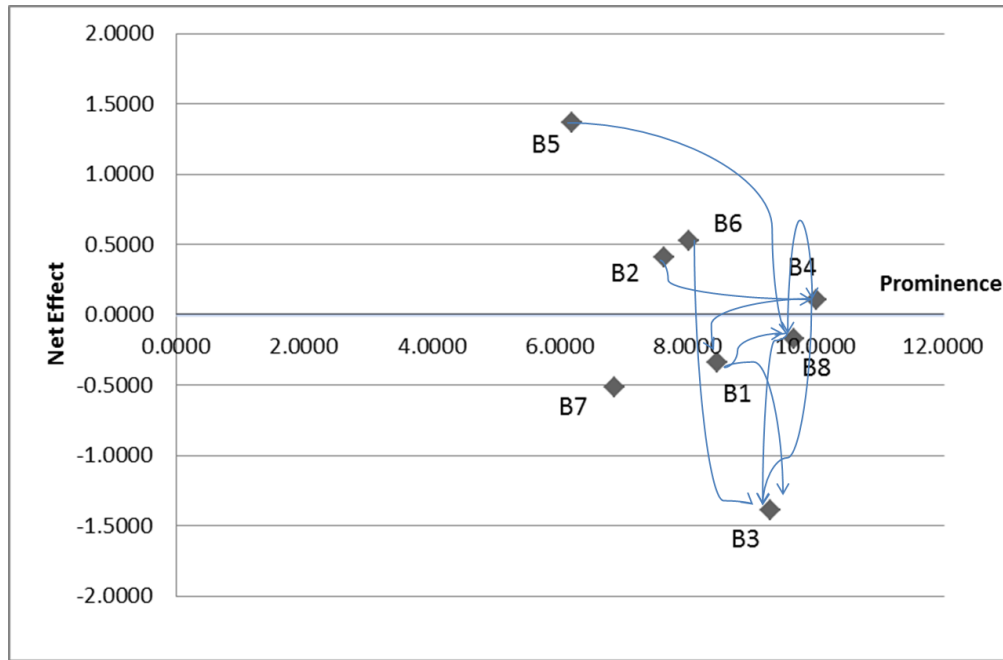


Fig.1. DEMATEL prominence-causal graph

As can be noticed in Table 3, four barriers B5, B6, B2 and B4 with net-effect value over zero become the most influential four barriers from ranking of net effect. Besides B5 which normally has been seemed as the biggest barrier between green product and consumers, it is interesting to see that B6 (Acknowledgement on influence of collaborative purchasing behavior) and B2 (Inadequate information on the product when purchasing) also have very high influence to other barriers. B6 was defined in the group of internal barriers which could be improved by education and advertisement. In this study, it shows that education to consumers on their purchasing behavior is needed. Furthermore, even B4 has the highest prominence value, it is also significantly influenced by B2 (0.6609). This means before choosing proper format of information presentation, it is more important to assure providing adequate quantity of necessary information.

In all, considering results from Table 3 and Fig. 1, it should be noticed that B4 with high prominence have also positive net effect, improving format of information presentation is crucial for increasing consumers' trusting on green products. Furthermore, B2 influences B4 significantly and it indicates that before choosing proper format of information presentation, it is more important to assure providing adequate quantity of necessary information. Therefore, these two factors should be addressed at first, as they have the greatest impact in the system. B6

(Acknowledgement on influence of collaborative purchasing behavior) has become one of the most important factors and play very important role in the whole system.

5. Conclusion

This study showed the interrelationship among barriers which exist between green product and their consumers by applying DEMATEL methodology. The analysis results showed the importance of various barriers, especially, improving format of information presentation is crucial for increasing consumers' trusting on green products. Moreover, it is important to assure providing adequate quantity of necessary information. How to provide adequate and necessary information is still require further investigation. Education and communication on consumers about impact of their collaborative purchasing behavior should be pursued. It has become one of the most important factors and could play very important role in the whole system. This study mainly considers the view from industrial expert, barrier analysis based on multiple stakeholders could provide more complete picture of an industry in the future. On the other hand, the results observed in fashion industry may not be consistent with other industry in Europe.

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References

- Amiri, M., Salehi, J., Payani, N., Shafieezadeh, M., 2011. Developing a DEMATEL method to prioritize distribution centers in supply chain 1, 279–288. doi:10.5267/j msl.2011.04.001
- Bonini, S.M.J., Oppenheim, J.M., 2008. Helping “ green ” products grow. The McKinsey Quaterly.
- Caniato, F., Caridi, M., Crippa, L., Moretto, A., 2012. Environmental sustainability in fashion supply chains: An exploratory case based research. *Int. J. Prod. Econ.* 135, 659–670. doi:10.1016/j.ijpe.2011.06.001
- Conference on “Visualising and Presenting Indicator Systems” SFSO, Neuchâtel 14 – 16 March 2005, 2005.
- Dahl, A.L., 2012. Achievements and gaps in indicators for sustainability. *Ecol. Indic.* 17, 14–19. doi:10.1016/j.ecolind.2011.04.032
- De Brito, M.P., Carbone, V., Blanquart, C.M., 2008. Towards a sustainable fashion retail supply chain in Europe: Organisation and performance. *Int. J. Prod. Econ.* 114, 534–553. doi:10.1016/j.ijpe.2007.06.012
- Dou, Y., Sarkis, J., 2013. A multiple stakeholder perspective on barriers to implementing China RoHS regulations. *Resour. Conserv. Recycl.* 81, 92–104. doi:10.1016/j.resconrec.2013.10.004

- EU, 2008. European Commission communication on the sustainable consumption and production and sustainable industrial policy action plan.
- Falatoonitoosi, E., Leman, Z., Sorooshian, S., Salimi, M., 2013. Decision-Making Trial and Evaluation Laboratory. *Res. J. Appl. Sci. Eng. Technol.* 5, 3476–3480.
- Grunert, K.G., Hieke, S., Wills, J., 2014. Sustainability labels on food products: Consumer motivation, understanding and use. *Food Policy* 44, 177–189. doi:10.1016/j.foodpol.2013.12.001
- Jalalifar, S., Hafshejani, K.F., Movahedi, M.M., 2013. Evaluation of the Effective Barriers in GSCM implementation Using DEMATEL Method. *Nat. Sci.* 11, 95–102.
- Khan, F.I., Sadiq, R., Veitch, B., 2004. Life cycle iNdeX (LInX): a new indexing procedure for process and product design and decision-making. *J. Clean. Prod.* 12, 59–76. doi:10.1016/S0959-6526(02)00194-4
- Lebel, L., Lorek, S., 2008. Enabling Sustainable Production-Consumption Systems. *Annu. Rev. Environ. Resour.* 33, 241–275. doi:10.1146/annurev.enviro.33.022007.145734
- Leire, C., Thidell, Å., 2005. Product-related environmental information to guide consumer purchases – a review and analysis of research on perceptions, understanding and use among Nordic consumers. *J. Clean. Prod.* 13, 1061–1070. doi:10.1016/j.jclepro.2004.12.004
- Lorek, S., Barber, J., Onthank, K., 2013. Global and Regional Research on Sustainable Consumption and Production Systems: Achievements, Challenges and Dialogues. Workshop Report of the Global Research Forum on Sustainable Production and Consumption. June 13-15, 2012, Rio.
- Luskin, J., Del Matto, T., 2007. Introduction to the special issue on, sustainable production and consumption: making the connection. *J. Clean. Prod.* 15, 489–491. doi:10.1016/j.jclepro.2006.05.009
- Maruchek, A., Greis, N., Mena, C., Cai, L., 2011. Product safety and security in the global supply chain: Issues, challenges and research opportunities. *J. Oper. Manag.* 29, 707–720. doi:10.1016/j.jom.2011.06.007
- Meise, J.N., Rudolph, T., Kenning, P., Phillips, D.M., 2014. Feed them facts: Value perceptions and consumer use of sustainability-related product information. *J. Retail. Consum. Serv.* 21, 510–519. doi:10.1016/j.jretconser.2014.03.013
- Moisander, J., 2007. Motivational complexity of green consumerism Johanna Moisander 4, 404–409.
- OECD, 2008. Promoting Sustainable Consumption-Good Practices in OECD Countries.
- Oslo, 1994. Symposium: Sustainable Consumption: 19-20, January 1994: Oslo, Norway.
- Pourabdollahian, G., 2013. Doctor Thesis-Qualitative Modeling of a Dynamic Sustainable Mass Customization Business Model. POLIMI.
- Rex, E., Baumann, H., 2007. Beyond ecolabels: what green marketing can learn from conventional marketing. *J. Clean. Prod.* 15, 567–576. doi:10.1016/j.jclepro.2006.05.013
- Rokka, J., Uusitalo, L., 2008. Preference for green packaging in consumer product choices - Do consumers care? *Int. J. Consum. Stud.* 32, 516–525. doi:10.1111/j.1470-6431.2008.00710.x

- Röös, E., Tjärnemo, H., 2011. Challenges of carbon labelling of food products: a consumer research perspective. *Br. Food J.* 113, 982–996.
- Shao, J., Taisch, M., Ortega, M., 2014a. A Systematic Review on Information Transition Approaches of Sustainable Production and Consumption (SPaC). submitted.
- Shao, J., Taisch, M., Ortega Mier, M., 2014b. Sustainability Assessment Instruments for Consumers, in: 20th Engineering, Technology and Innovation (ICE 2014). Bergamo, Italy. doi:10.1109/ICE.2014.6871624
- Tseng, S.-C., Hung, S.-W., 2013. A framework identifying the gaps between customers' expectations and their perceptions in green products. *J. Clean. Prod.* 59, 174–184. doi:10.1016/j.jclepro.2013.06.050
- UN, 1992. United Nations Conference on Environment & Development Rio de Janeiro , Brazil , 3 to 14 June 1992.
- UNDP, 1998. HUMAN DEVELOPMENT REPORT 1998. New York.
- Vermeir, I., Verbeke, W., 2006. Sustainable Food Consumption: Exploring the Consumer “Attitude – Behavioral Intention” Gap. *J. Agric. Environ. Ethics* 19, 169–194. doi:10.1007/s10806-005-5485-3
- Worldwatch, 2004. THE WORLDWATCH INSTITUTE SPECIAL FOCUS: THE CONSUMER SOCIETY.
- Wu, W.-W., Lee, Y.-T., 2007. Developing global managers' competencies using the fuzzy DEMATEL method. *Expert Syst. Appl.* 32, 499–507. doi:10.1016/j.eswa.2005.12.005
- Zhu, Q., Sarkis, J., Debroux, P., 2011. Barriers to environmentally-friendly clothing production among Chinese apparel companies. *Asian Bus. Manag.* 10, 425–452. doi:10.1057/abm.2011.15
- Zhu, Q., Sarkis, J., Lai, K., 2008. Green supply chain management implications for “closing the loop”. *Transp. Res. Part E Logist. Transp. Rev.* 44, 1–18. doi:10.1016/j.tre.2006.06.003

Appendix

Appendix A. The grey pairwise direct-relation matrix X

Barriers	B1	B2	B3	B4	B5	B6	B7	B8
B1	x	1	3	2	1	4	2	4
B2	1	x	2	3	1	2	4	4
B3	3	2	x	3	1	3	2	3
B4	4	4	3	x	2	3	2	3
B5	4	2	2	2	x	1	3	3
B6	4	3	3	2	1	x	2	3

B7	1	2	2	2	3	2	x	2
B8	3	3	3	3	2	2	3	x

Appendix B. The overall crisp direct-relationship matrix Z

Barriers	B1	B2	B3	B4	B5	B6	B7	B8
B1	0.0000	0.0500	0.9167	0.5000	0.0833	0.9500	0.3500	0.9500
B2	0.0500	0.0000	0.5000	0.9167	0.0833	0.3500	0.9500	0.9500
B3	0.6500	0.3500	0.0000	0.9167	0.0833	0.6500	0.3500	0.6500
B4	0.9500	0.9500	0.9167	0.0000	0.5000	0.6500	0.3500	0.6500
B5	0.9500	0.3500	0.5000	0.5000	0.0000	0.0500	0.6500	0.6500
B6	0.9500	0.6500	0.9167	0.5000	0.0833	0.0000	0.3500	0.6500
B7	0.0500	0.3500	0.5000	0.5000	0.9167	0.3500	0.0000	0.3500
B8	0.6500	0.6500	0.9167	0.9167	0.5000	0.3500	0.6500	0.0000

Appendix C, The normalized direct-relation matrix N

Barriers	B1	B2	B3	B4	B5	B6	B7	B8
B1	0.0000	0.0101	0.1846	0.1007	0.0168	0.1913	0.0705	0.1913
B2	0.0101	0.0000	0.1007	0.1846	0.0168	0.0705	0.1913	0.1913
B3	0.1309	0.0705	0.0000	0.1846	0.0168	0.1309	0.0705	0.1309
B4	0.1913	0.1913	0.1846	0.0000	0.1007	0.1309	0.0705	0.1309
B5	0.1913	0.0705	0.1007	0.1007	0.0000	0.0101	0.1309	0.1309
B6	0.1913	0.1309	0.1846	0.1007	0.0168	0.0000	0.0705	0.1309
B7	0.0101	0.0705	0.1007	0.1007	0.1846	0.0705	0.0000	0.0705
B8	0.1309	0.1309	0.1846	0.1846	0.1007	0.0705	0.1309	0.0000

Appendix D, The total-relation matrix T

Barriers	B1	B2	B3	B4	B5	B6	B7	B8
B1	0.4578	0.3866	0.7119	0.5966	0.2579	0.5567	0.4284	0.6608
B2	0.4499	0.3750	0.6264	0.6609	0.2796	0.4379	0.5378	0.6493
B3	0.5566	0.4298	0.5371	0.6486	0.2547	0.4977	0.4228	0.6030
B4	0.7177	0.6180	0.8353	0.6301	0.3837	0.5973	0.5322	0.7440
B5	0.5769	0.3990	0.5966	0.5574	0.2325	0.3754	0.4620	0.5807
B6	0.6317	0.4984	0.7353	0.6257	0.2671	0.4144	0.4550	0.6464
B7	0.3705	0.3535	0.5078	0.4817	0.3595	0.3520	0.2945	0.4523
B8	0.6359	0.5455	0.7913	0.7484	0.3781	0.5158	0.5507	0.5833

$$N = sZ \quad (1)$$

$$s = \frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n z_{ij}} \quad (2)$$

$$T = N + N^2 + N^3 + \dots \sum_{i=1}^{\infty} N^i = N(I - N)^{-1} \quad (3)$$

$$R_i = \sum_{j=1}^n t_{ij} \quad \forall i \quad (4)$$

$$D_j = \sum_{i=1}^n t_{ij} \quad \forall j \quad (5)$$

$$P_i = \{R_i + D_j | i = j\} \quad (6)$$

$$E_i = \{R_i - D_j | i = j\} \quad (7)$$